

THE MINIMUM COST OF TRANSPORTING HYDROGEN VIA TRUCKS BETWEEN FRANCE AND GERMANY

European Hydrogen Energy Conference – EHEC 2018

MARCH 15TH 2018 | AMIN LAHNAOUI, CHRISTINA WULF, HEIDI
HEINRICHS, DIDIER DALMAZZONE

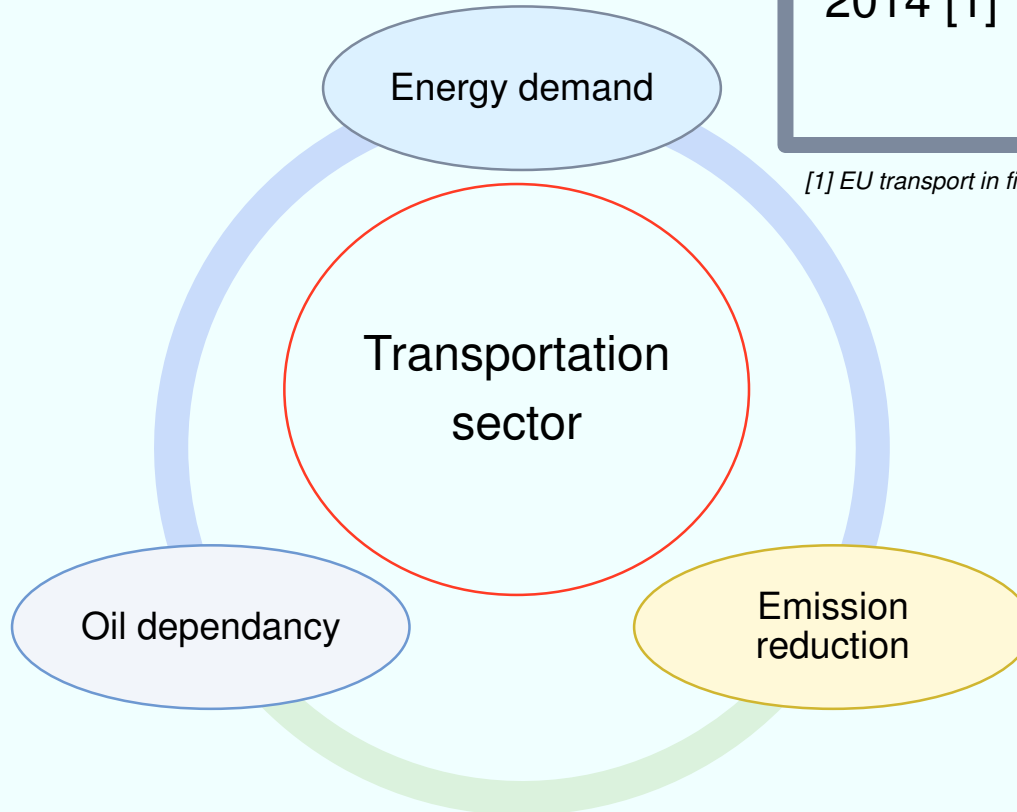
SYSTEMS ANALYSIS AND TECHNOLOGY EVALUATION (IEK-STE)

INTRODUCTION

European context

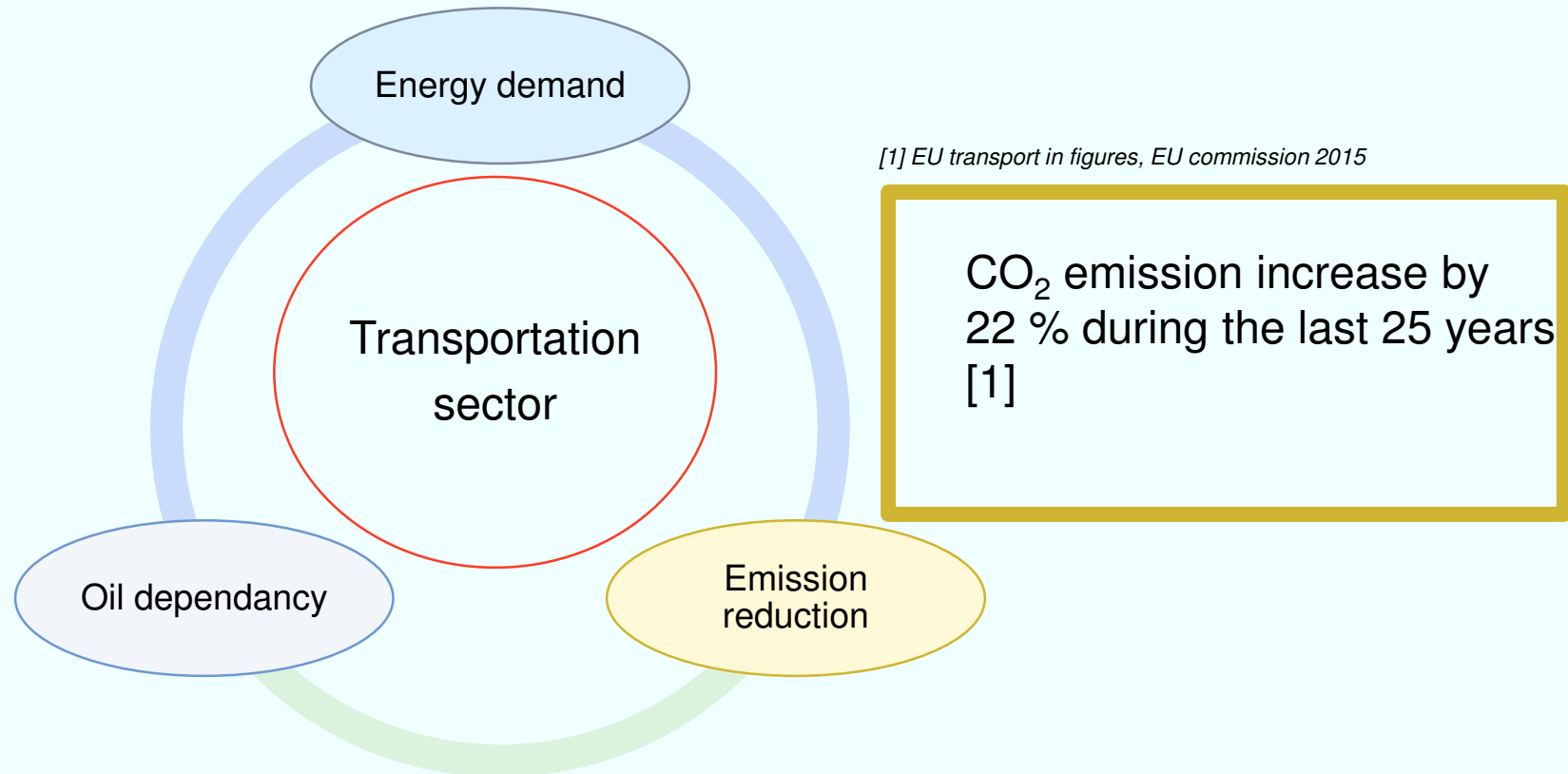
32 % of the EU final
energy consumption in
2014 [1]

[1] EU transport in figures, EU commission 2015



INTRODUCTION

European context

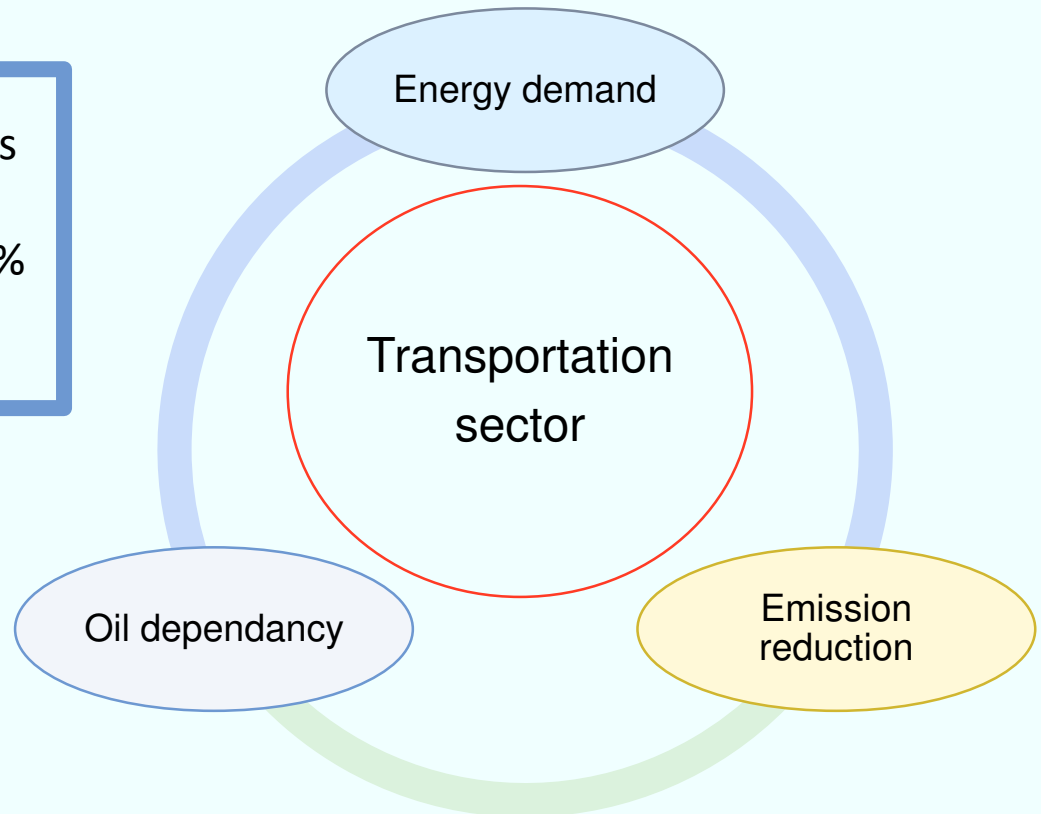


INTRODUCTION

European context

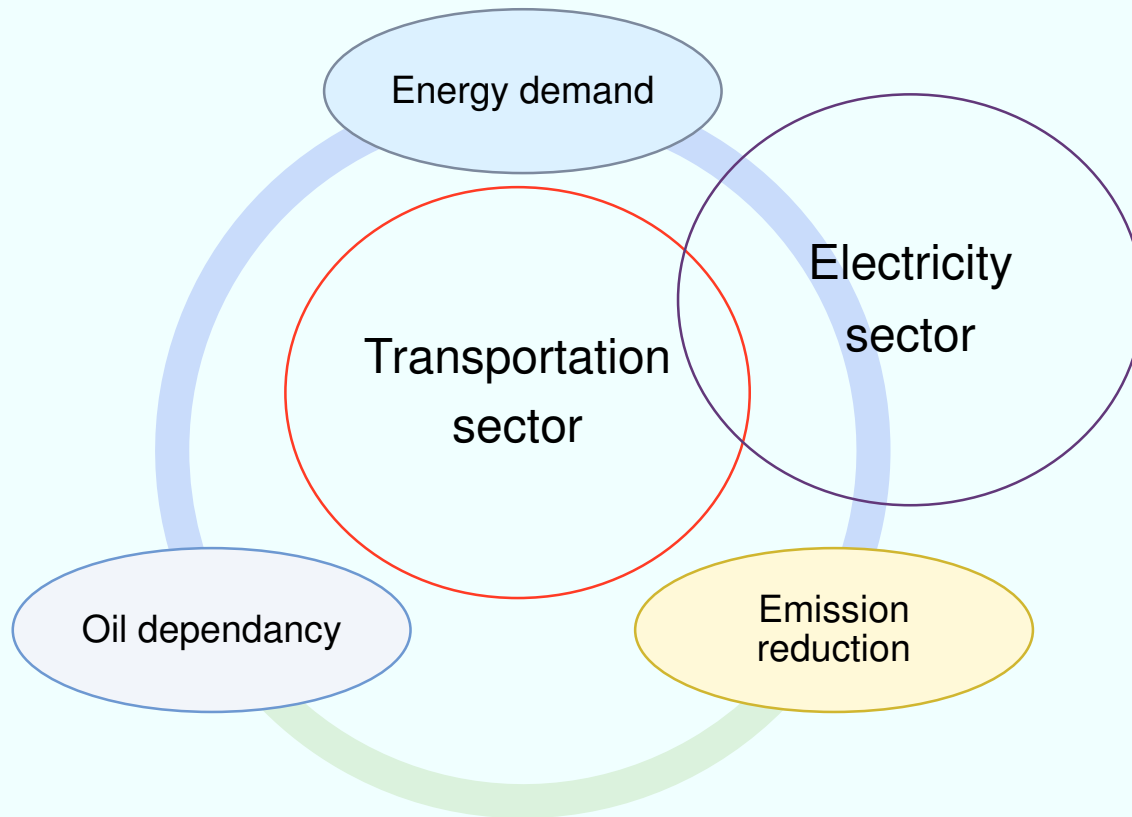
Share of alternative fuel vehicles among newly registered passenger cars in 2015 was < 2 %
[2]

[2] Statistical pocketbook 2017 - EU transport in figures



INTRODUCTION

European context

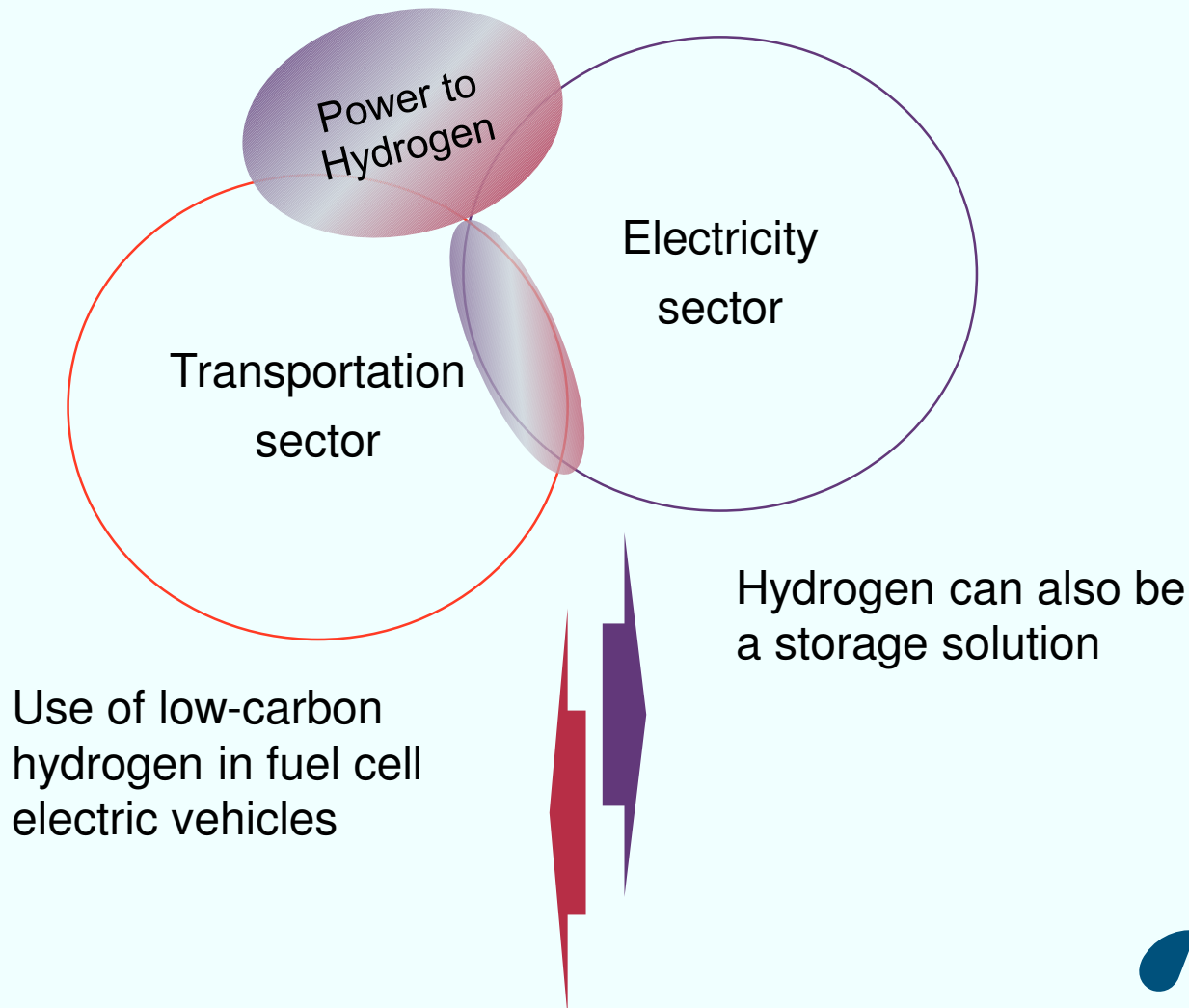


An increase of 22 % of the global generation from RE in 2015 [3], increases excess electricity

[3] Tracking clean energy progress 2015 – International Energy Agency, IEA

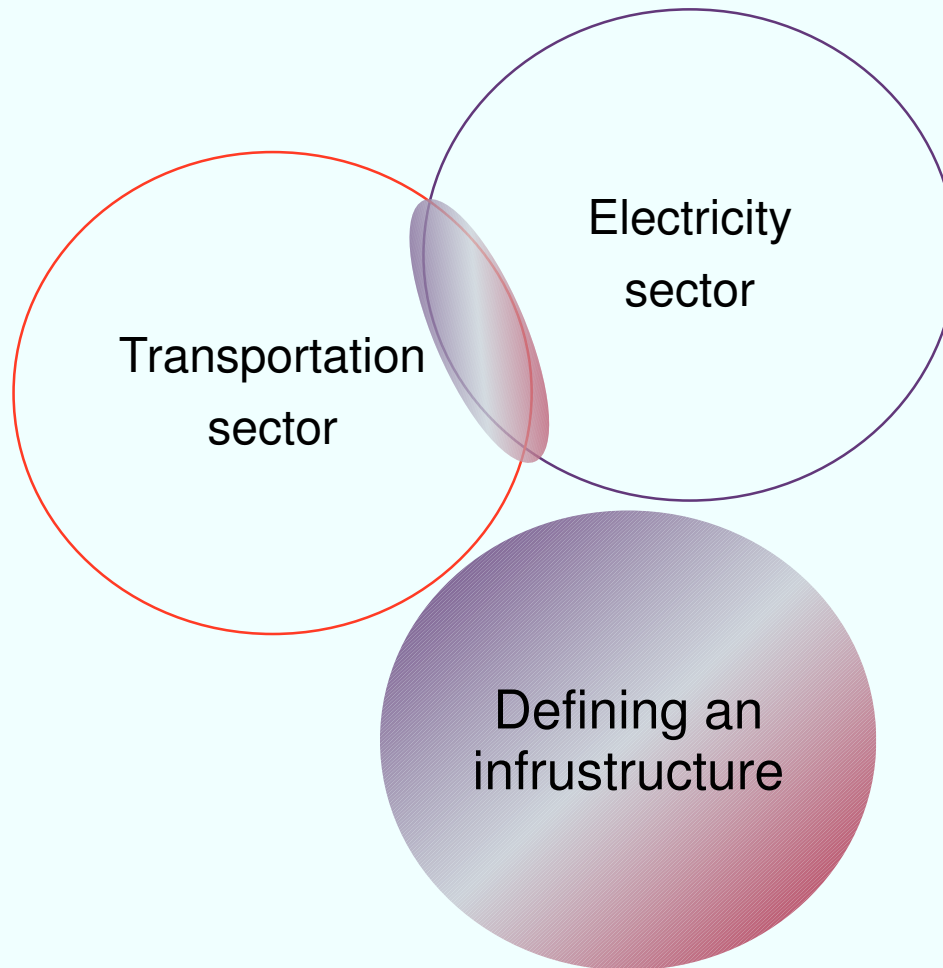
INTRODUCTION

Power to Hydrogen as a coupling vector



INTRODUCTION

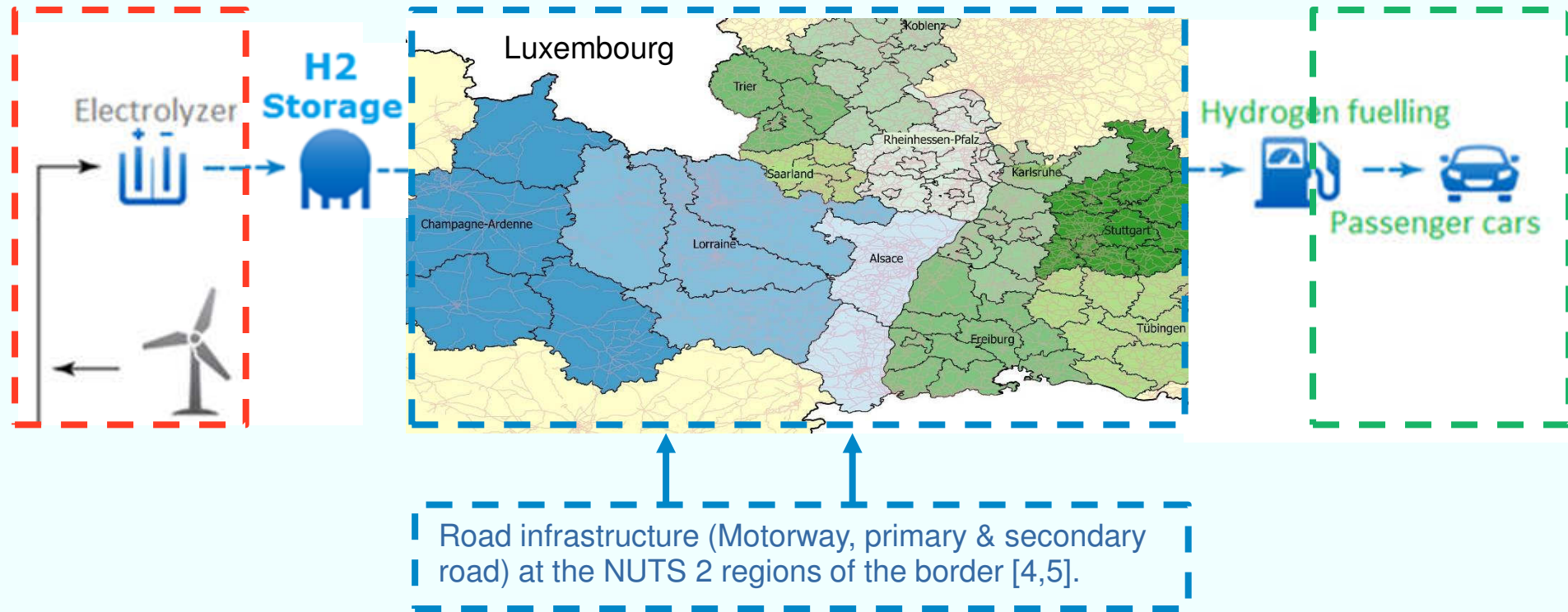
Power to Hydrogen as a coupling vector



MODEL FRAMEWORK

Hydrogen supply chain

Time frame: 2030

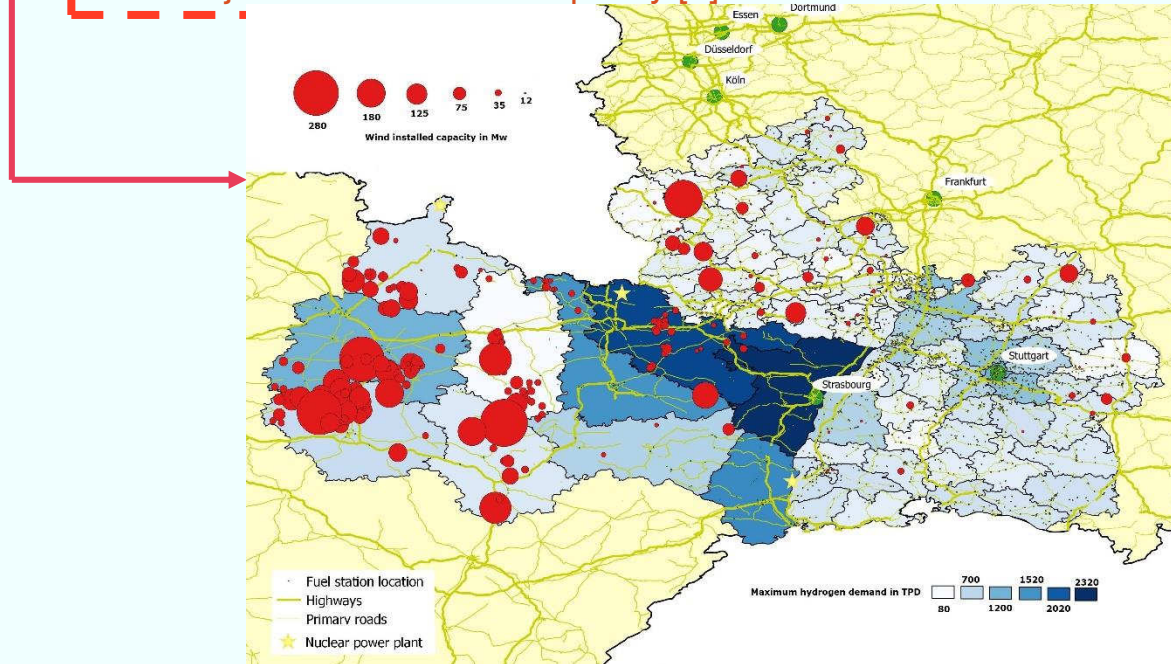


NUTS regions in France [4] and in Germany [5]. EUROSTAT, European statistics

MODEL FRAMEWORK

Input parameters

- Current share of regional installed capacity to the national one [6,7]
- Projection of installed capacity [8]

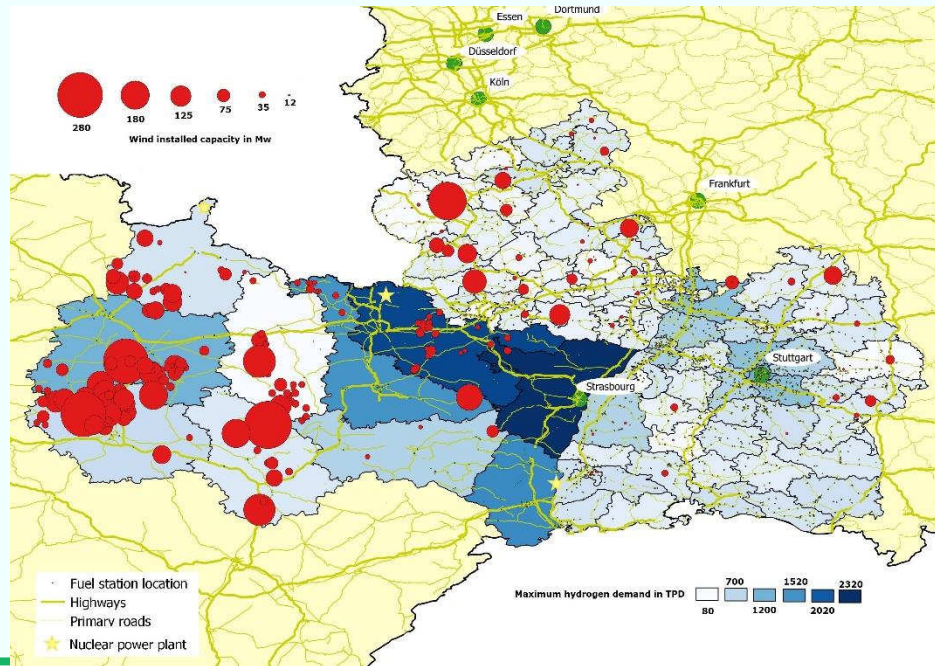


Installed capacity, zones Baden-Württemberg, Saarland and Rheinland-Pfalz [6] and zones 08, 10, 51, 52, 54, 55, 57, 67, 68 and 88 [7]. The Wind Power.

[8] Wind energy scenarios for 2030. European Wind Energy Association

MODEL FRAMEWORK

Input parameters



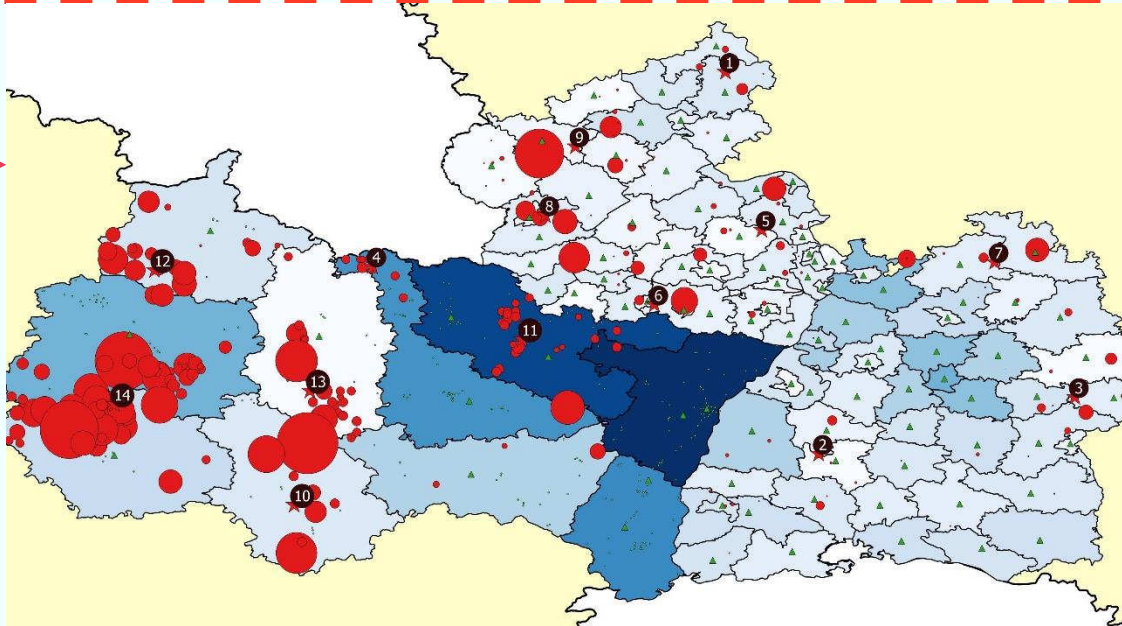
- Projection of population and average distance travelled per capita [9,10]
- Scenario for the share of FCEV in new fuel [11]

Population projections data [9] and Passenger road transport on national territory, by type of vehicles registered in the reporting country [10]. EUROSTAT, European statistics
[11] *Technology Roadmap, Hydrogen and Fuel Cells*. International Energy Agency, IEA

MODEL FRAMEWORK

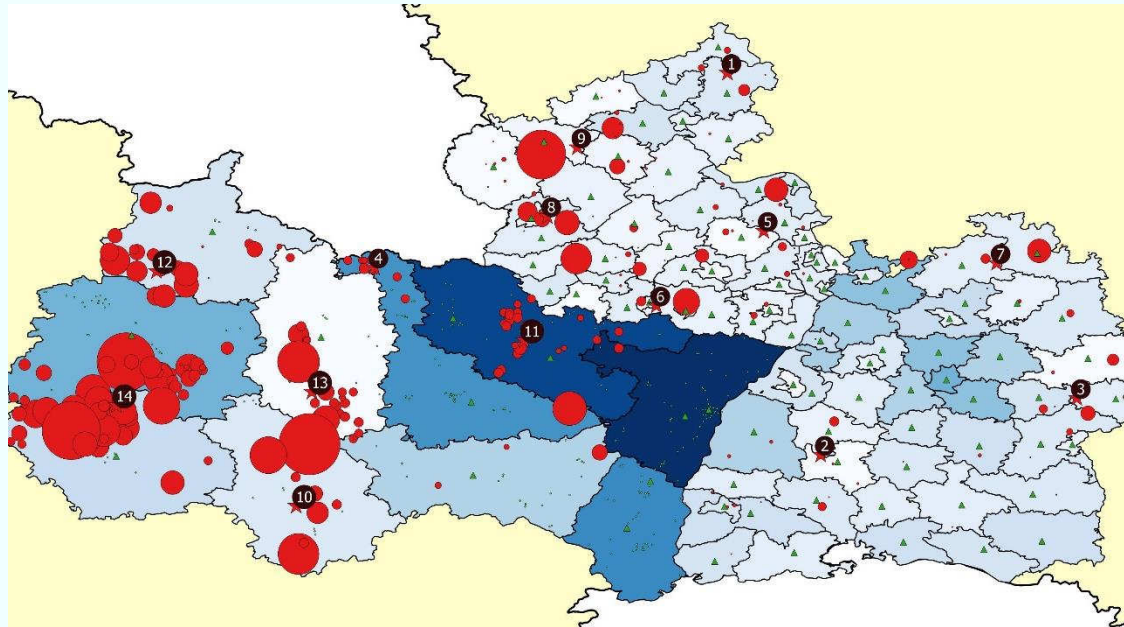
Input parameters

- Maximum distance between production locations as an input parameter
- Center of mass of hydrogen production



MODEL FRAMEWORK

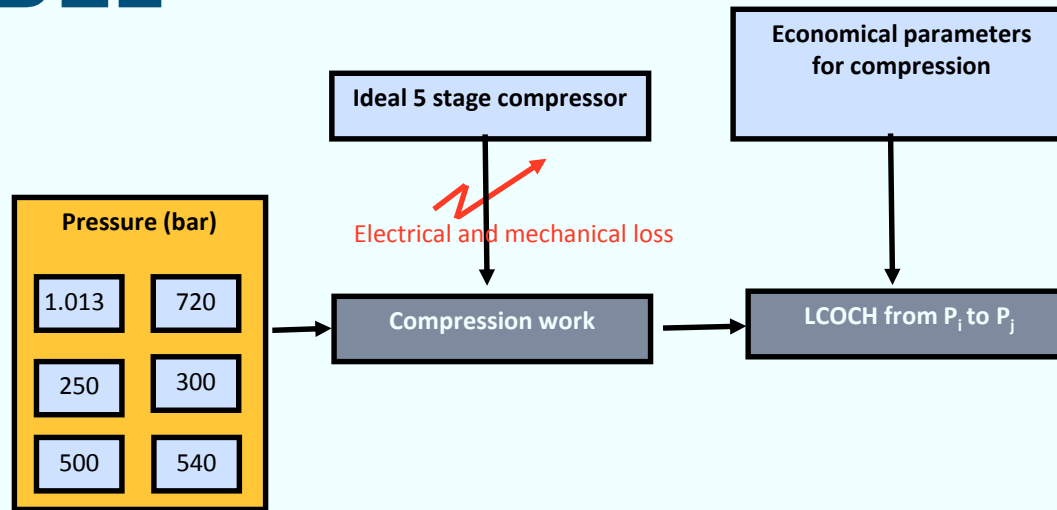
Input parameters



- Distribution as a center of NUTS 3 regions [4,5]
- Center of mass of the distribution of the refueling stations (FR)

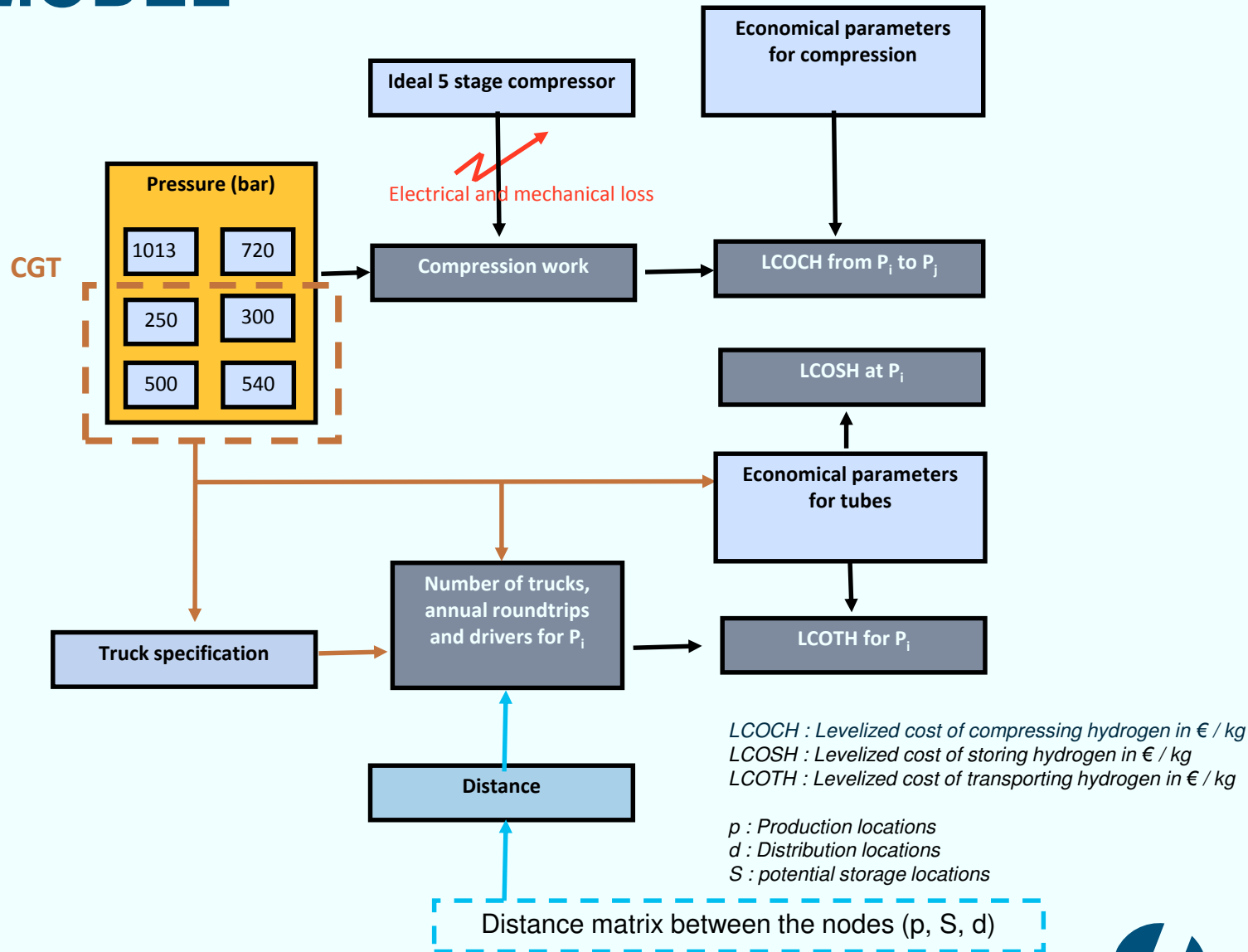
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MODEL

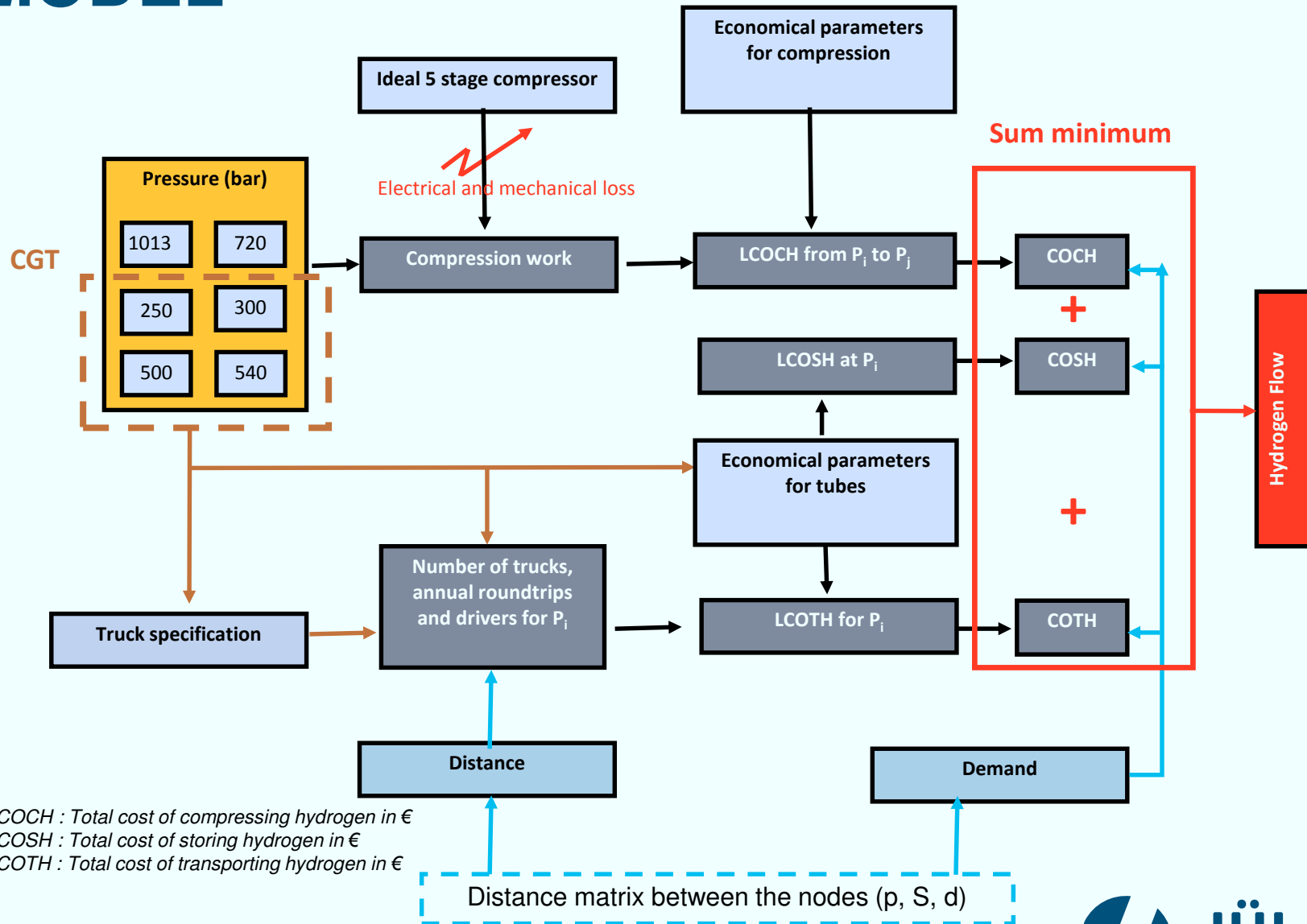


LCOCH : Levelized cost of compressing hydrogen in € / kg
 P_i & P_j : pressure levels

MODEL



MODEL

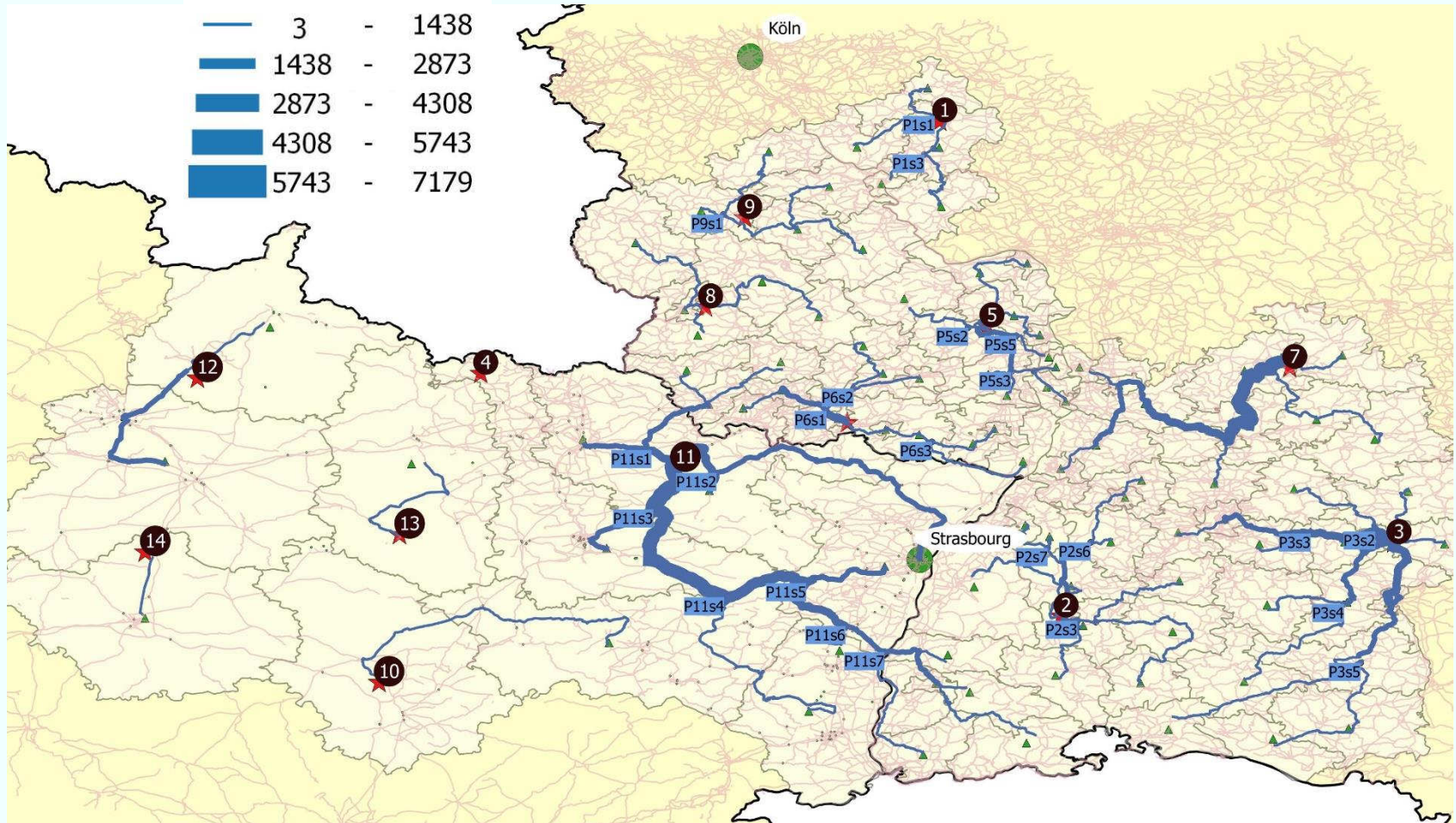


COCH : Total cost of compressing hydrogen in €
 COSH : Total cost of storing hydrogen in €
 COTH : Total cost of transporting hydrogen in €

Distance matrix between the nodes (p, S, d)

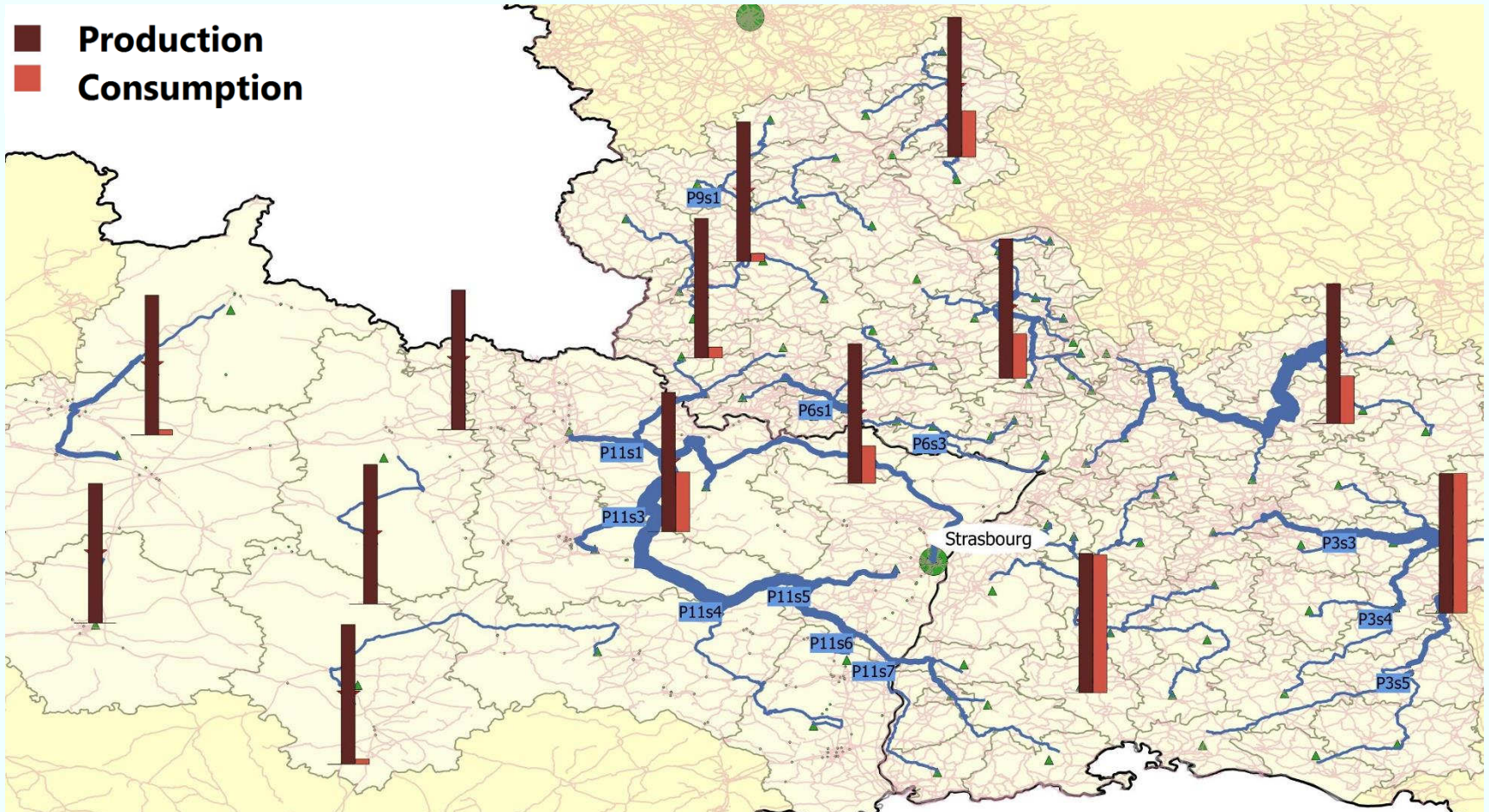
RESULTS

Flow distribution in TPD



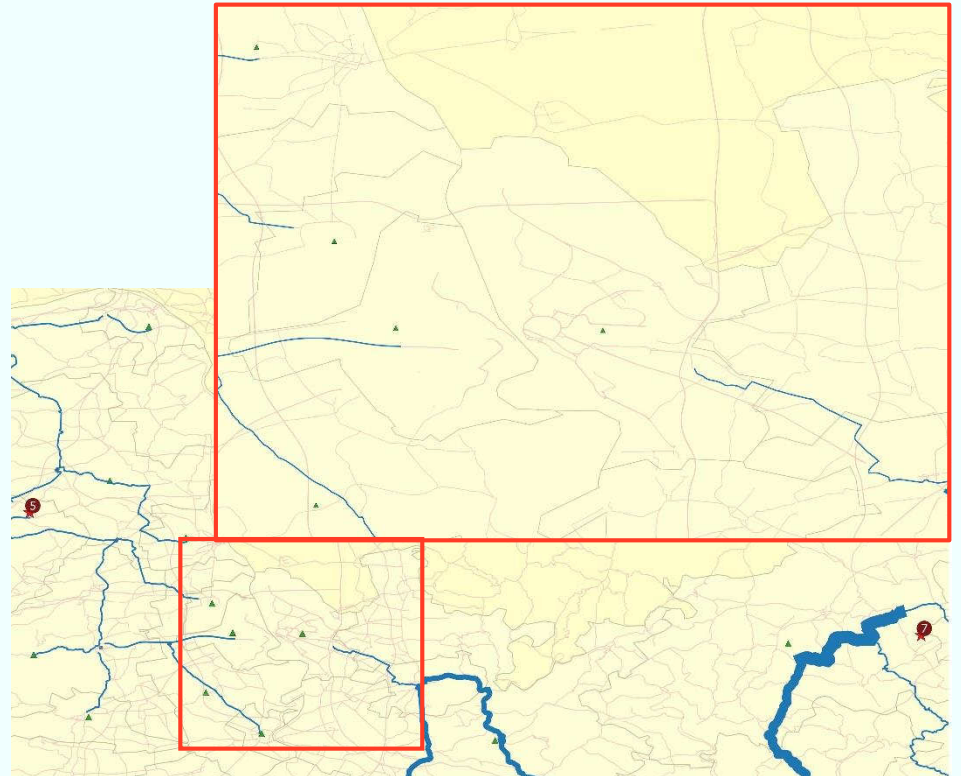
RESULTS

Hydrogen production in thousand TPD



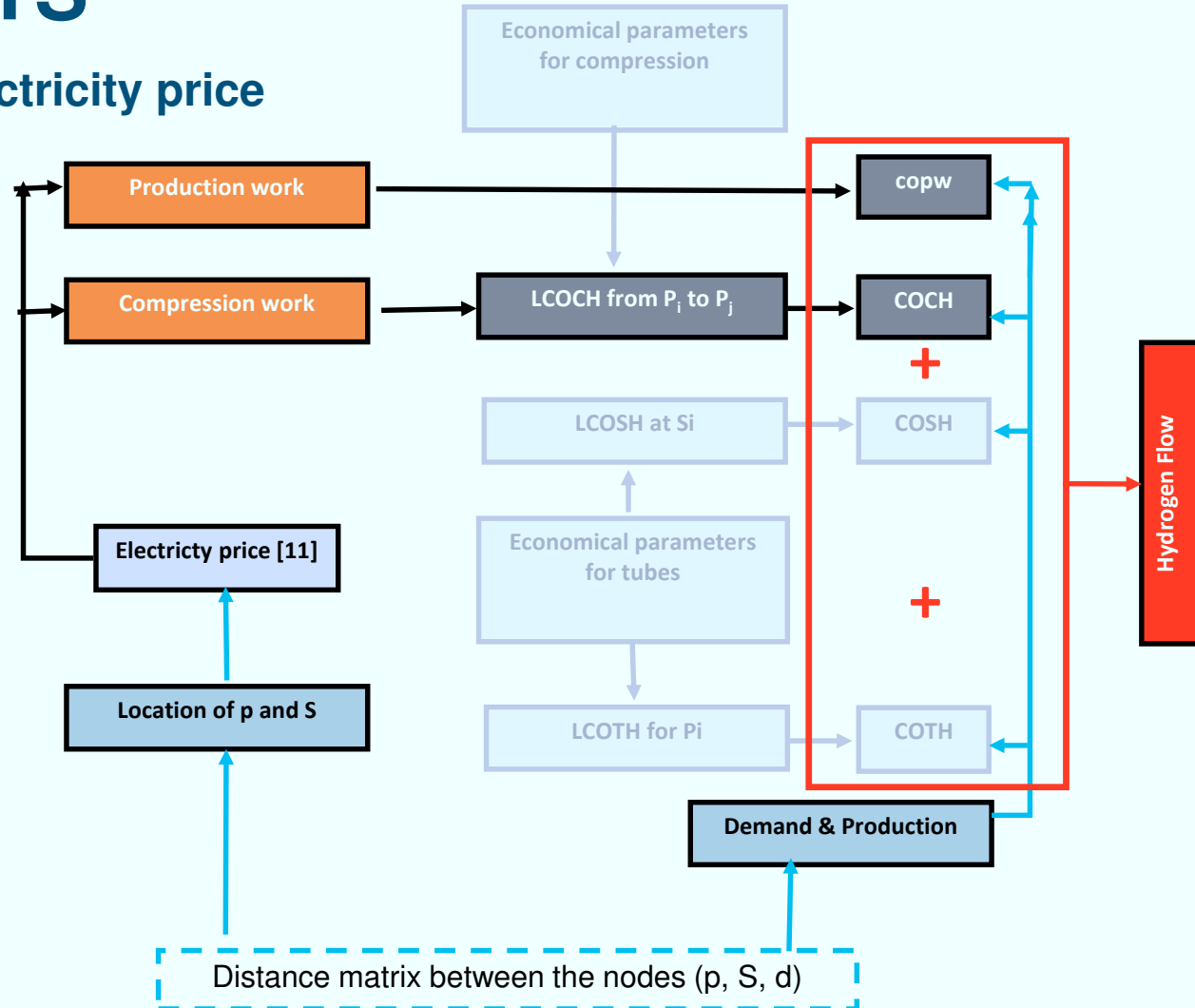
RESULTS

Discussion



RESULTS

Impact of electricity price



[11] Electricity price statistics. EUROSTAT, European statistics

copw: cost associated to production work

RESULTS

Production in thousand TPD



[11] Electricity price statistics. EUROSTAT, European statistics

*: cost including all taxes and levies

	Production in TPD	Consumption in TPD	
		= electricity price	# electricity price
11 (F)	32900	-14000	-17200
8 (G)	15090	-1200	-1200
6 (G)	13407	-3600	<u>-1300</u>
5 (G)	12640	-4000	-4000
2 (G)	5230	-5200	<u>-4400</u>

(F) 0.07 € / kWh [11]* (G) 0.13 € / kWh [11]*

CONCLUSION

- The short term scenario of 2030 is not impacted by the locations of hydrogen production
 - The main distribution is covered by local production
 - 95 % of production in France is not locally consumed
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